Quantum computation with Aharonov-Bohm qubits and qugates

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We analize the possibility of employing mesoscopic/nanoscopic rings of normal metal in a double degenerate persistent-current state in presence of the Aharonov-Bohm flux equal to half of normal-metal flux quantum, hc/e, as an entangled quantum bits of information (qu-bits) [1,2]. Unlike in traditional qubits with two quantum states, three-site AB loop has an additional state serving as a quantum logic gate (qu-gate). This state couples, through the externally applied electric field perpendicular to the magnetic flux, to the degenerate levels allowing to perform full set of quantum transformations (NOT, CNOT, Hadamard and input/output operations) required for universal quantum computation. Theoretical decoherence rates of such qubits-qugates related to coupling with the electromagnetic environment proved quite small thus promising for principal realization of scalable molecular quantum computation.

[1] A.Barone, T.Hakioglu and I.O.Kulik, preprint cond-mat/0203038.
[2] I.O.Kulik, T.Hakioglu, A.Barone, Eur.Phys.J. B30, p.219 (2002).